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(54) Improvements in and relating to cooling apparatus

(57) A heat sink and cooler for a portable radio transmitter comprises an aluminium casing 5 whose interior is split up into water compartments 18, 20, 22 and 24, in communication with each other, and an air compartment 26 which is sealed from the water compartments. The electrical or electronic components 6 are mounted on the outside of the casing 5 and they and the casing are mounted inside a thermally insulated outer case 32. Heat produced by the components 6 is dissipated in the water. The water is cooled by passing air through the compartment 26. The air flow may be switched on intermittently, for example when the transmitter is not operating, so as to remove heat previously stored in the water during a cycle of operation of the transmitter. Instead, the air flow can be on continuously while the transmitter is operating.

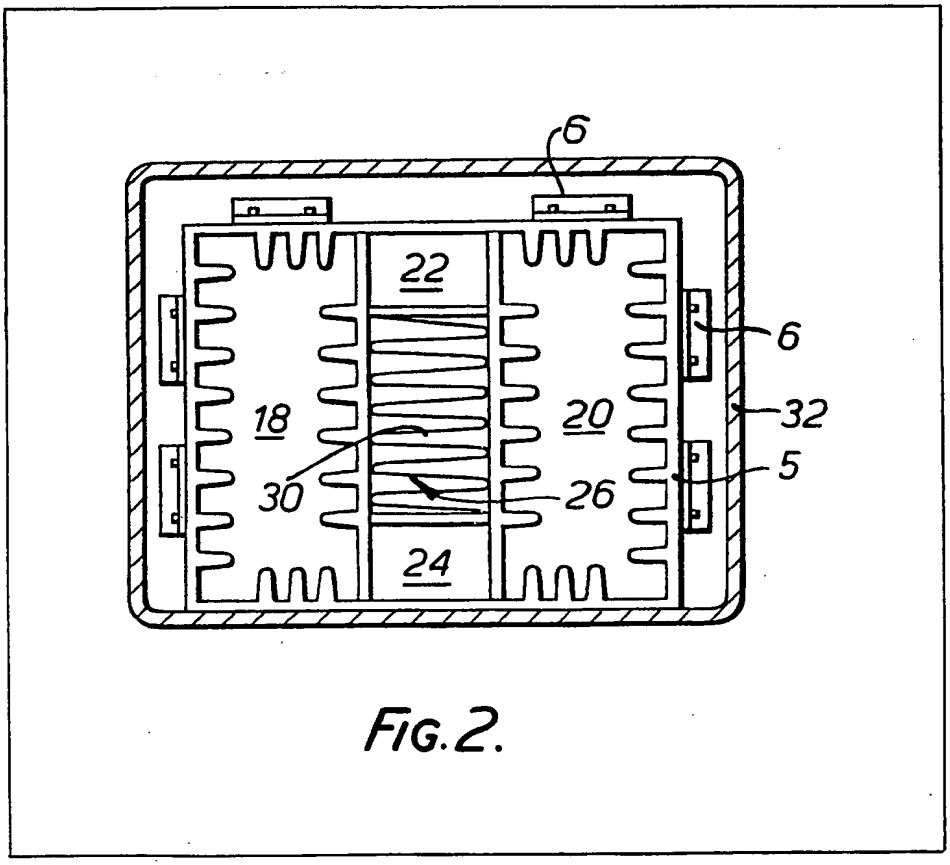

FIG. 2.

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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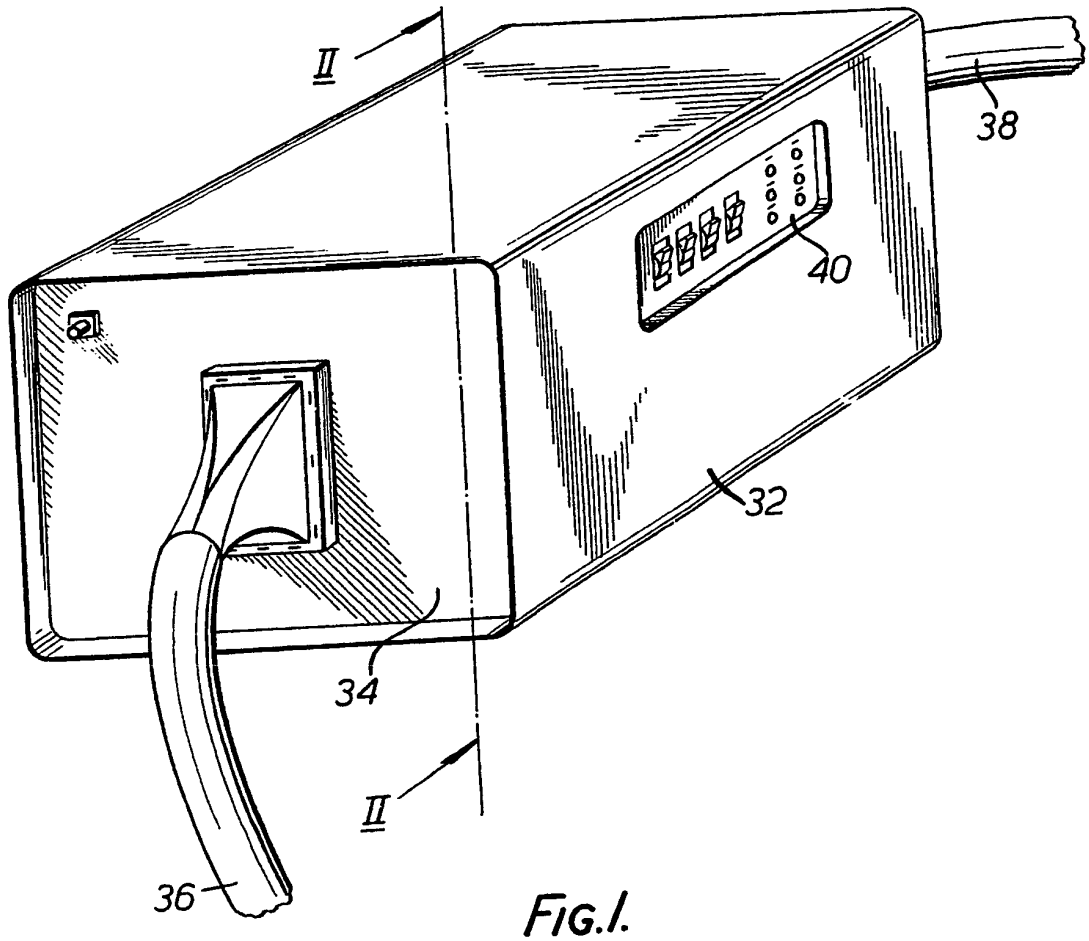

FIG.1.

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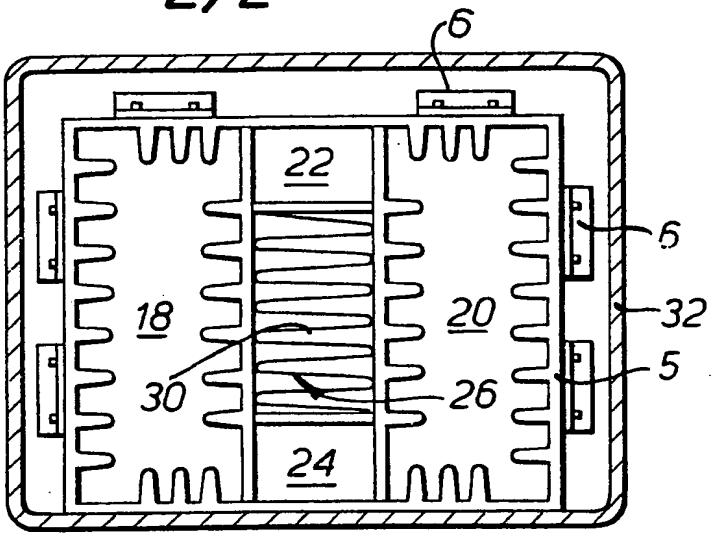

FIG. 2.

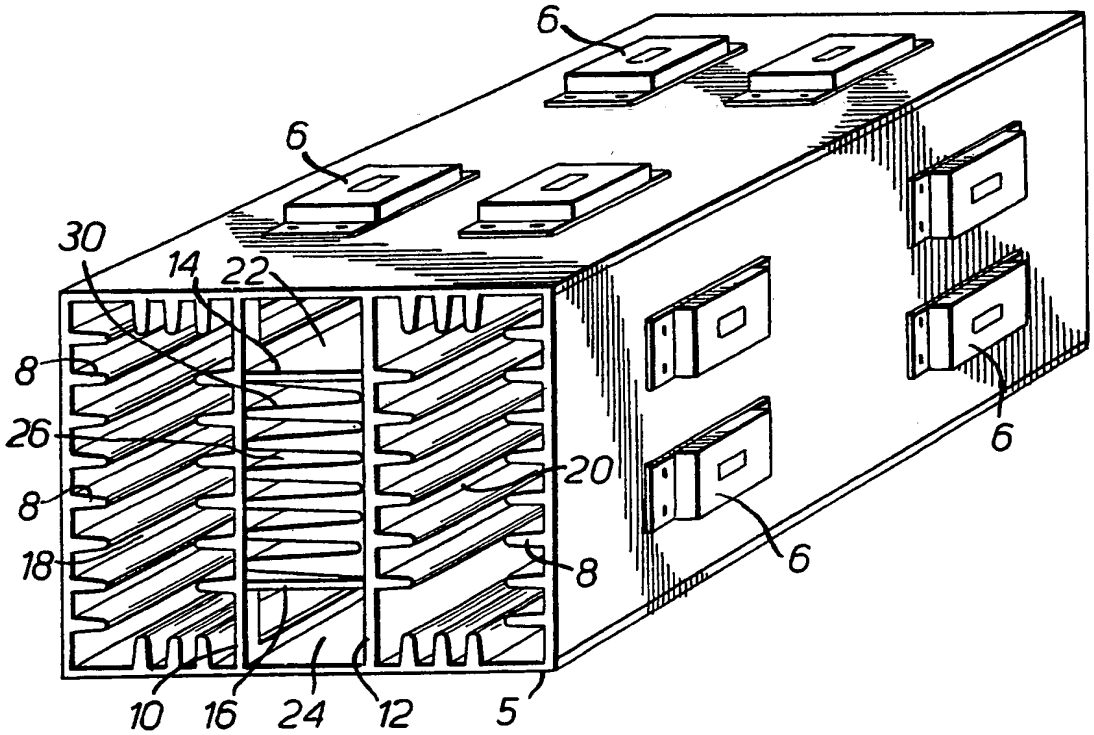

FIG. 3.

SPECIFICATION

Improvements in and relating to cooling apparatus

The invention relates to cooling apparatus and more specifically to apparatus for acting as a heat sink for electronic components.

Various novel features of the invention will be apparent from the following description, given by way of example only, of cooling apparatus embodying the invention, reference being made to the accompanying diagrammatic drawings, in which:

Figure 1 is a perspective view of the apparatus;

Figure 2 is a diagrammatic cross-section taken on the line II—II of Figure 1; and

Figure 3 is a perspective view of an internal part of the apparatus.

More specifically to be described below is apparatus for cooling electrical or electronic components, comprising a chamber for holding a liquid of relatively high specific heat such as water, means for mounting the electrical or electronic components externally of the chamber but so as to be in good thermally conductive relationship with the liquid in the chamber, means defining a passageway through or adjacent to the chamber so as to be sealed therefrom but in good thermally conductive relationship with liquid in the chamber, and means for selectively passing a fluid, such as air, through the passageway so as to remove heat from the liquid.

In one specific example, the chamber is in the form of one or more interconnected compartments within a casing made of thermally conductive material on the outside of which the electrical or electronic components may be mounted, the passageway passing through the interior of the casing. The compartments may, for example, be arranged within the casing around the passageway which passes centrally through the casing.

The casing is advantageously mounted within an outer thermally insulated case which defines between the outside of the casing and the inside of the insulated case a space in which the electrical or electronic components may be mounted.

In a more specific sense, there will be described below in more detail apparatus for cooling electrical or electronic components, comprising an outer thermally insulated case, an inner casing made of thermally conductive material and mounted inside the outer case but defining with the inner walls thereof a space to enable mounting of the electrical components on the outside of the thermally conductive casing, dividing walls within the thermally conductive casing which define a central compartment running substantially symmetrically through the casing and one or more other compartments sealed from but surrounding the central compartment, means for filling the one or more other compartments with liquid of relatively high specific heat such as water for receiving and dissipating heat from the electrical or electronic components in use, and means selectively operable to pass a fluid such as air through the central compartment so as to carry heat away from the water, the inner walls being thermally conductive.

The apparatus to be described in more detail now is intended, in this example, to act as a heat sink for those components of a radio transmitter which produce significant heat when the transmitter is operating and for enabling dissipation of this heat. However, the apparatus may be used to dissipate heat from other electronic components.

As shown in Figures 2 and 3, the apparatus includes a rectangular casing 5 made of a material of a good heat conductivity such as aluminium. The electronic components 6 for which the apparatus is to act as a heat sink and which are to be cooled thereby, are mounted externally on the casing 5 so as to be in good thermal contact with the casing. The inside walls of the casing are finned as shown at 8, and the casing also includes two finned dividing walls 10 and 12. Further cross walls 14 and 16 extend between the walls 10 and 12. The inside of the casing 5 is thus divided into compartments 18, 20, 22, 24 and 26. However, the walls 10 and 12 are provided with openings 28 which place the compartments 18, 20, 22 and 24 in communication with each other. The compartment 26 is sealed off from the remaining compartments and includes metal fluting 30 dividing it into a number of passages running longitudinally through the casing 5.

The casing 5 includes end plates (not shown) which close off the ends of the compartments 18, 20, 22 and 24 in a water-tight manner.

Figure 2 shows how the casing 5 is mounted in a case 32, made of steel or other suitable material. The inside wall of the case 32 is spaced from the electronic components 6 and is thermally insulated so as to minimize the escape of heat outwardly through the case.

Figure 1 shows the case 32 in more detail, and in particular shows how the ends of the case are sealed off with end plates. The end plate 34 has a central aperture which supports a flexible air outlet connection 36. This is connected, through the end plate 34, to the adjacent open end of the compartment 26 (see Figures 2 and 3). At its opposite end, the case 32 carries a similar end plate supporting an air inlet connection 38 which is sealingly connected, through that end plate, with the adjacent open end of the compartment 26.

In use, the compartments 18, 20, 22 and 24 are filled with water. During operation of the electrical equipment of which the components 6 form part, the heat produced by the components 6 is dissipated through the casing 5 into the water. As the compartments 18, 20, 22 and 24 are in communication with each other, the water can freely circulate by virtue of the convection currents set up and the heat therefore rapidly becomes dissipated from the immediate vicinities of the components 6 and, of course, raises the

temperature of the water.

In order to remove the heat taken up by the water, air is passed through the compartment 26 via the air connections 36, 38, shown in Figure 1, air being drawn through these passageways and the compartment 26 by means of a suitable fan (not shown).

The apparatus may be operated in various different modes.

For example, in one such mode the air flow is switched off while the components 6 are operating and dissipating their heat into the water. Then when the electrical apparatus of which the components 6 form part is switched off, the air flow is switched on so as to cool the water and render it ready for taking up heat again from the components 6 when they are next energised. Such a mode may be useful, for example, when the electrical equipment of which the components 6 form part is portable equipment carried by a vehicle. When the vehicle is stationary and the electrical equipment is in use, being energised by batteries, the air flow is off thereby avoiding additional drain on the batteries and also avoiding dissipation of heat outside the vehicle. When the electrical equipment has finished a duty cycle, and the vehicle is once more mobile, the air flow can then be switched on so as to dissipate the heat from the water.

In another mode, however, the air can be flowing through the compartment 26 while the electronic components 6 are energised and will therefore dissipate heat from the water continuously.

The air connections 36 and 38 preferably include valves so as to prevent the flow of heat outwardly through these passageways by means of convection currents when the air flow is not switched on. In this way, as much as possible of the heat produced by the components 6 in use can be retained within the outer case 32 until the air flow is switched on.

The apparatus may be designed to operate with a water temperature range of, say, —10°C to 85°C. The casing 5 may incorporate an expansion chamber for the water and/or a pressure relief valve, and may also incorporate a warning light to indicate when the water temperature is becoming too high.

For use in cold conditions, the water may include an anti-freeze agent.

Liquids other than water may be used instead if water is not available.

Figure 1 shows a control and indicator panel 40 by means of which the air supply may be switched on and off and where indication of excessive temperature may be given.

When the apparatus is used in an armoured vehicle, for example, it can be self-contained and, because it does not require continuous flow of air in order to dissipate the heat, it is not necessary for the armour of the vehicle to be modified to provide an air inlet and an air exit. The air passageways 36 and 38 can simply be passed out through one of the vehicle doors when the vehicle is mobile.

The arrangement of the various compartments as shown in Figures 2 and 3 is merely one of various possible arrangements.

It may be advantageous under certain circumstances to fit a pump to aid circulation of the water through the compartments 18, 20, 22 and 24.

CLAIMS

1. Apparatus for cooling electrical or electronic components, comprising a chamber for holding a liquid of relatively high specific heat such as water, means for mounting the electrical or electronic components externally of the chamber but so as to be in good thermally conductive relationship with the liquid in the chamber, means defining a passageway through or adjacent to the chamber so as to be sealed therefrom but in good thermally conductive relationship with liquid in the chamber, and means for selectively passing a fluid, such as air, through the passageway so as to remove heat from the liquid.

2. Apparatus according to claim 1, in which the chamber is in the form of one or more interconnected compartments within a casing made of thermally conductive material on the outside of which the electrical or electronic components are mounted, the passageway passing through the interior of the casing.

3. Apparatus according to claim 2, in which the compartments are arranged within the casing around the passageway which passes centrally through the casing.

4. Apparatus according to any preceding claim, in which the casing is mounted within an outer thermally insulated case which defines between the outside of the casing and the inside of the insulated case a space in which the electrical or electronic components are mounted.

5. Apparatus for cooling electrical or electronic components, comprising an outer thermally insulated case, an inner casing made of thermally conductive material and mounted inside the outer case but defining with the inner walls thereof a space to enable mounting of the electrical components on the outside of the thermally conductive casing, dividing walls within the thermally conductive casing which define a central compartment running substantially symmetrically through the casing and one or more other compartments sealed from but surrounding the central compartment, means for filling the one or more other compartments with liquid of relatively high specific heat such as water for receiving and dissipating heat from the electrical or electronic components in use, and means selectively operable to pass a fluid such as air through the central compartment so as to carry heat away from the water, the inner walls being thermally conductive.

6. Apparatus according to any preceding claim,

arranged to act as a heat sink for those components of a radio transmitter which produce significant heat when the transmitter is operating.

7. Apparatus for cooling electrical or electronic components, substantially as described with reference to the accompanying drawings.

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